

# RESEARCH IMPLEMENTATION REPORT

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STAP Number		Contract Number 59A0249	EA 680420	Performance Period March 2001 – June 2004
Report Date June 2004	Report No. SSRP 2004/08	Report Title Investigation of Integrity and Effectiveness of RC Bridge Deck Rehabilitation with CFRP Composites		
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<b>Abstract</b> Deterioration and functional deficiency of civil infrastructure continues to pose a significant challenge to civil engineers. Approximately 28% of bridges in the United States were structurally deficient or functionally obsolete in 2000. Due to limited resources, innovative methodologies and tools are being developed to efficiently manage the degradation and structural deficiencies present in the existing infrastructure. While some researchers are engaged in developing methods of rehabilitation, others are focused on developing methodologies to monitor structures. However, rehabilitation and monitoring have not been integrated and applied to bridges in service. This report develops methodologies to evaluate the integrity and effectiveness of external bonding of carbon fiber reinforced polymer (CFRP) composites to the bridge deck soffit of Spans 8 and 9 of the eastbound structure. Wet lay-up and pultruded CFRP composites are applied to the deteriorated decks of the Watson Wash Bridge. A global vibration-based nondestructive evaluation procedure measuring changes in modal strain energy is used to determine stiffness changes in the bridge structure before and after application of CFRP composites. The effect of CFRP composite material variation and degradation are incorporated into a measure of the reliability index, which is related to the probability of failure; failure is defined as the yield of steel reinforcement. The reliability index combines the effects of material variation, CFRP composite degradation, and measured stiffness changes from the field in order to assess the service life of a FRP rehabilitated structure as shown from a series of progressive damage tests. Based upon the results of the measured system changes, effects of material variation and CFRP composite degradation; CFRP rehabilitation designs are recommended for the parallel westbound Watson Wash Bridge. Recommended CFRP rehabilitation designs are intended to prevent the occurrence of punching shear failure, and sustain HS20 and Permit Load demands in the longitudinal and transverse slab directions for a period greater than 25 years at a reliability level of 3.5, which is equivalent to a failure probability of 0.02%.				
<b>Achievement</b> A cost comparison between recommended CFRP rehabilitation and new bridge construction shows a savings of 75 to 80% by rehabilitation of the entire bridge deck area of the existing westbound Watson Wash Bridge				
<b>Conclusion &amp; Recommendation</b> The Damage Index Method is effective in localizing stiffness changes in the deck slab following rehabilitation with CFRP composite materials. The purpose of the global NDE procedure was to measure changes in stiffness of the deck slab following rehabilitation. Using the measure of the reliability index and an allowable reliability limit of 3.5, it is possible to extend the service life of an FRP rehabilitated structure in the presence of degradation in CFRP composite tensile properties for a period greater than 25 years. It is found that the cost of FRP rehabilitation to sustain HS20 loads is approximately 20% of the cost of new bridge construction.				
Contract Manager Charles Sikorsky		Technical Support Team FRP Composite Committee		
<b>Implementation Recommendations</b> <ul style="list-style-type: none"><li>• Implement a health monitoring strategy on critical bridges to develop remaining service-life.</li><li>• Apply durability characterization of CFRP composite materials from exposure to other environments, such as immersion in saltwater and alkali solution, to the performance of an FRP rehabilitated T-girder structure.</li><li>• Apply service life estimation procedure with available on-line monitoring approaches to provide a basis for decisions of repair, replacement or no action.</li><li>• Rehabilitate other bridges (such as WB structure) using the methodology developed in this project.</li></ul>				
<b>Implementation Measures Taken</b> None at this time				